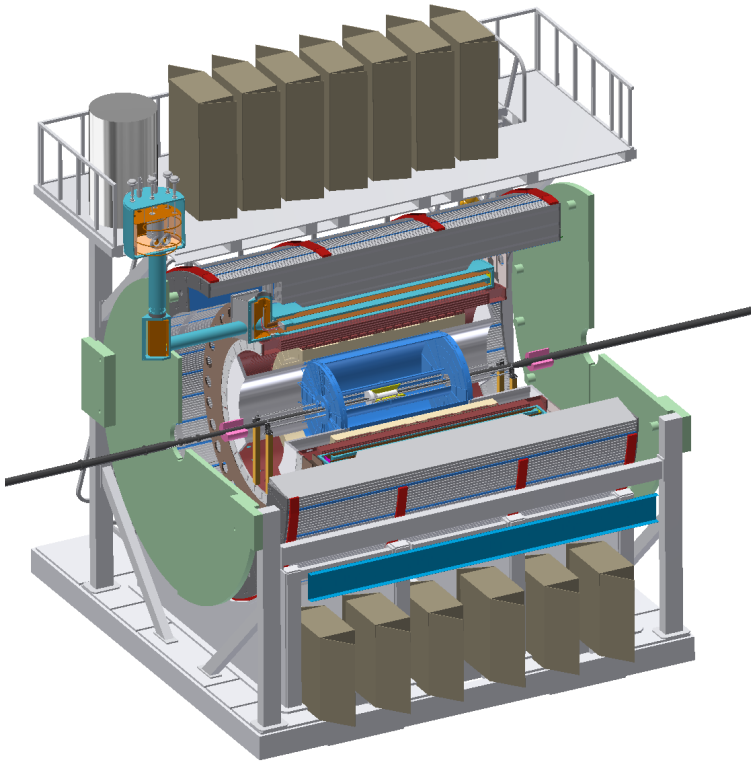
# sPHENIX Magnet, Infrastructure, Integration and Installation

Don Lynch

6/6/2017

# Scope of sPHENIX
# Magnet, Infrastructure, Integration and Installation



| WBS | sPHENIX MIE Project Elements |
|---|---|
| 1.1 | Project Management |
| 1.2 | Time Projection Chamber |
| 1.3 | Electromagnetic Calorimeter |
| 1.4 | Hadron Calorimeter |
| 1.5 | Calorimeter Electronics |
| 1.6 | DAQ-Trigger |
| 1.7 | Minimum Bias Trigger Detector |

| WBS | Infrastructure & Facility Upgrade |
|---|---|
| 1.8 | SC-Magnet |
| 1.9 | Infrastructure |
| 1.10 | Installation-Integration |

| WBS | Parallel Activities |
|---|---|
| 1.11 | Intermediate Silicon Strip Tracker |
| 1.12 | Monolithic Active Pixel Sensors |

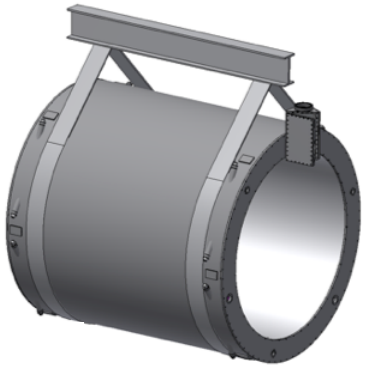
# WBS 1.8: sPHENIX Superconducting Magnet: Scope

**Scope begins after high field tests in building 912**

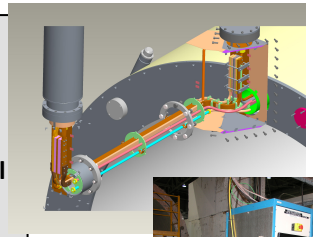
**Disassembly of equipment from high field test (including valve box) and prep for transport to 1008**

**Transport to 1008**

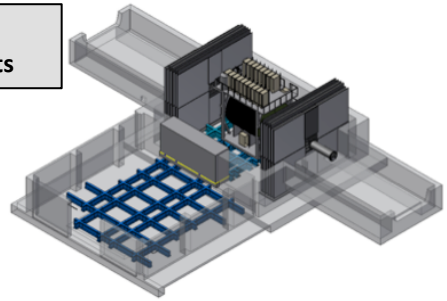
***(mechanically install magnet onto Outer HCal until after HCal installed and cradle carriage work platforms installed is under WBS 1/10 scope. Mechanical support structure for power and cryo supply lines are designed and procured under WBS 1.9 and installed under WBS 1.10)***



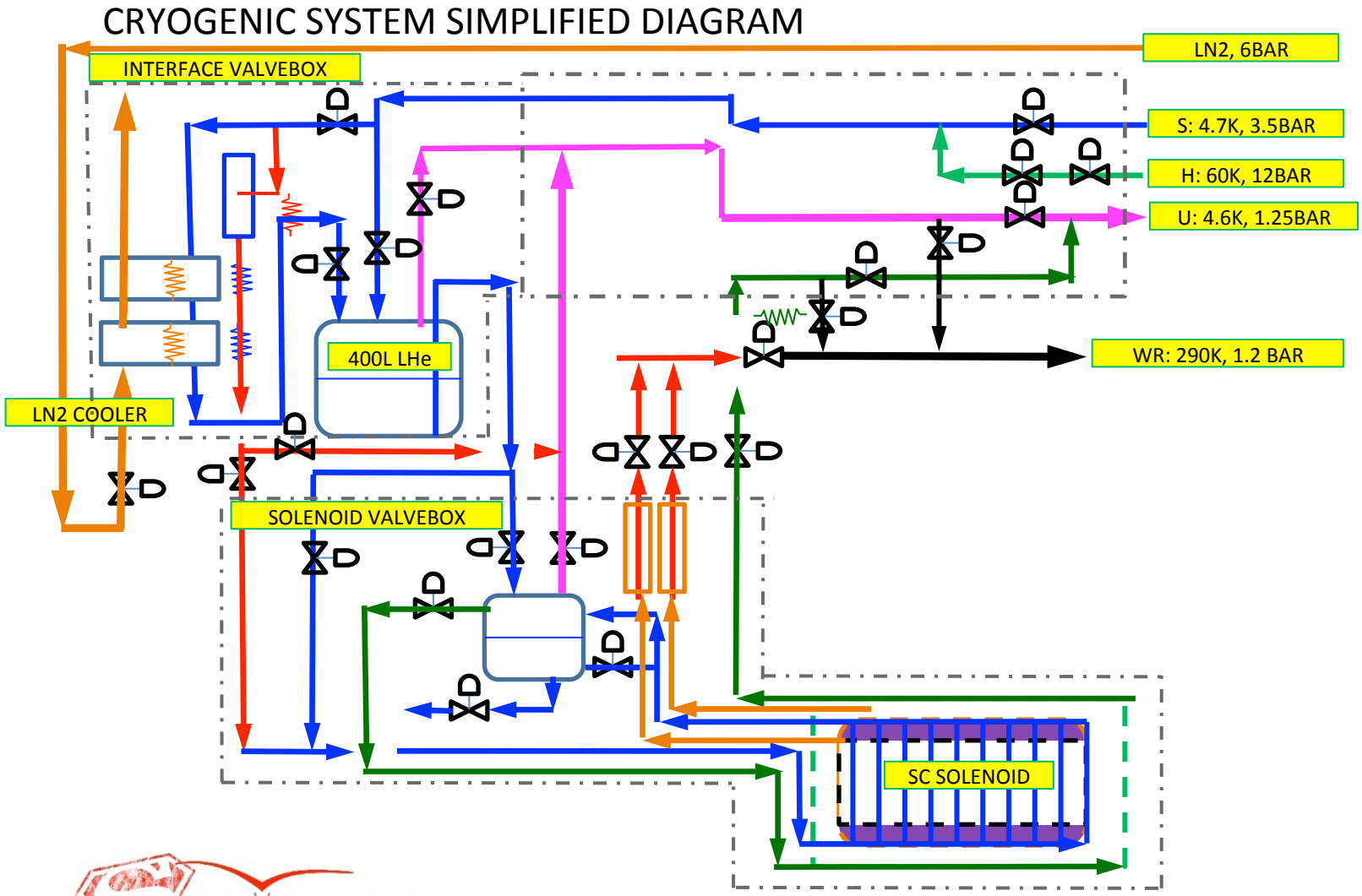
**Reinstall valve box, install power supplies control system hardware and cryo tap to RHIC cryo supply system, route power, control and cryo services from source to 1008 IR and integrate with magnet.**

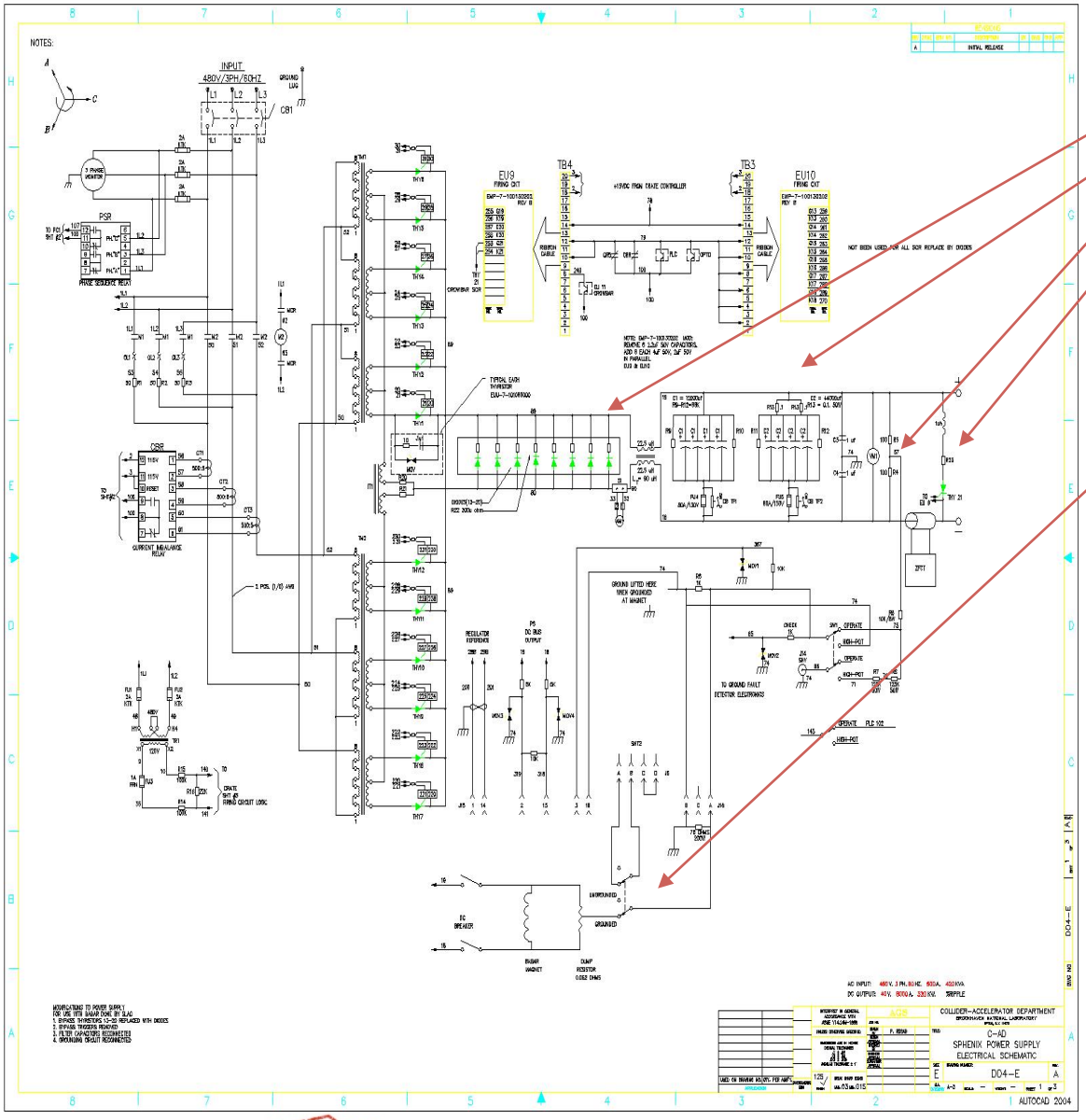


**Perform magnet tests**



# SPHENIX: MAGNET: Cryogenics System diagram






PS POWER SECTION

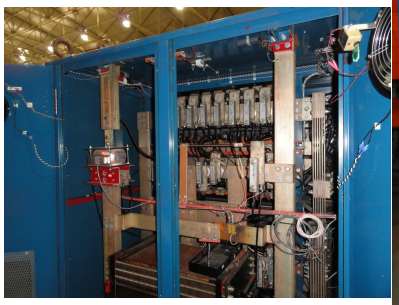
SCR – REPLACE BY FREE WHEELING DIODES

CAP BANK RECONFIGURATION

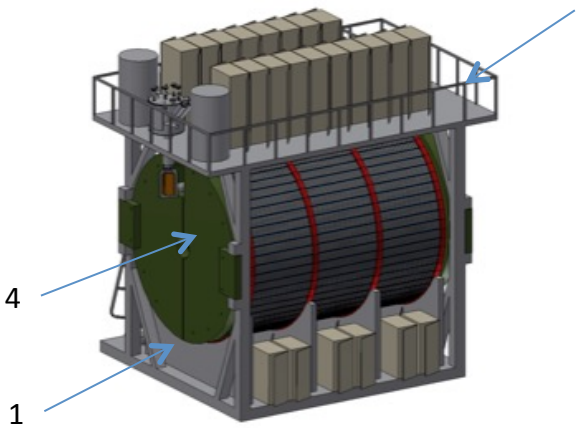
PS GROUND DETECTOR

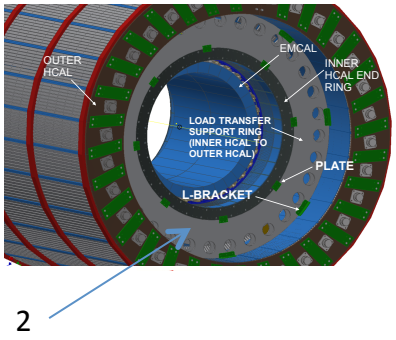
PS CROWBAR CIRCUIT

DUMP RESISTOR GROUND SW1



# Infrastructure Description/Scope




Provide the detector Central Pedestal Support and Interconnecting hardware and support structures.

1. Support Pedestal, rollers, vertical and horizontal positioning assembly
2. End Ring for transitional support of the Inner Hcal Assembly to the Outer Hcal
3. Provide Electronics Bridge and Access Stairs
4. Magnet Pole Tips (Flux return endcaps)

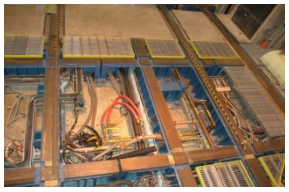
Existing Facility

Conventional Systems
(Mostly Repurposed from PHENIX Equipment)

- A/C Power
- Piping Supports (Cryo Pipe)
- Cable Tray
- Cooling Water
- Assembly Building/Control Room/Support Buildings
- HSSD, Leak Detection, Pass System, ODH
- Gas Distribution System
- Subsystem dedicated cooling

Existing Power

Existing Water System



Existing Distribution


Existing Power

# Example of repurposing

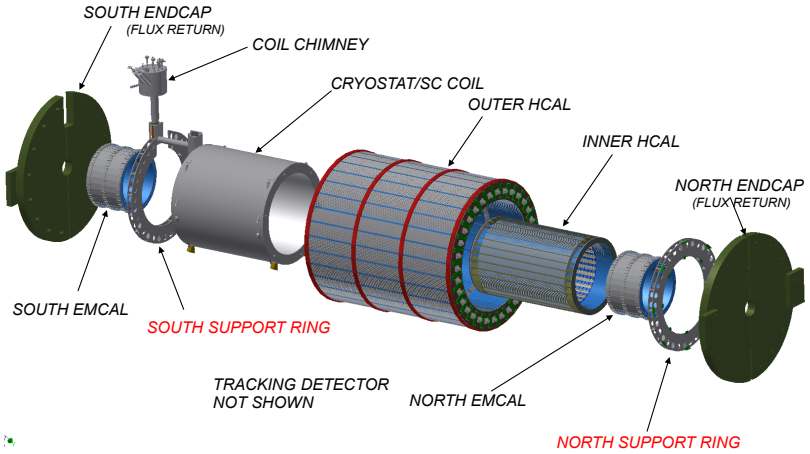
- All PHENIX racks transported to 912 and activation checked
- Most original racks being stripped
  - Items sorted for reuse (din rail blocks , LV power supplies, HV main frames, heat exchangers, etc.)
  - Items beyond their usable lifetime will be recycled.
- Racks from PHENIX upgrades kept mostly intact for reuse in sPHENIX

# Specification/Requirements Infrastructure

- Pole Tips
  - 204” OD x 24” ID x 12” Thick
  - Material – C1006 Magnet Steel
  - Detector Accessibility Requirements – Extended Maintenance (1week)
- Support Ring
  - Material – Stainless, 400 Series
  - Load Requirements – Transfer support loads from Inner HCal/EMCal to Outer Hcal
- Access Bridge
  - Accommodate Racks, Cryo Valve Box, Dewars (2), Controls
  - Design Floor Load Requirement – 150 PSF
- Cradle and Base
  - Design Load Requirement – 628T
  - Detector Verti./Horiz. Alignment Requirements - ±0.020 in. Vert/Horiz. , ±0.050 in. longitudinal. (proposed)
  - Detector Travel Speed Requirement – 1’/min. (proposed)
- Vacuum Pipe
  - Reuse of 31.5 inch long beryllium section
  - Other modifications to conventional beampipe sections
- Conventional Systems
  - Cooling Water – provide 2 gpm @ 50F Supply - 2 KW/Rack
  - HVAC – 68F/50%RH
  - Existing 480V, 1200A Buss
  - TPC Gas System
  - Subsystem dedicated cooling

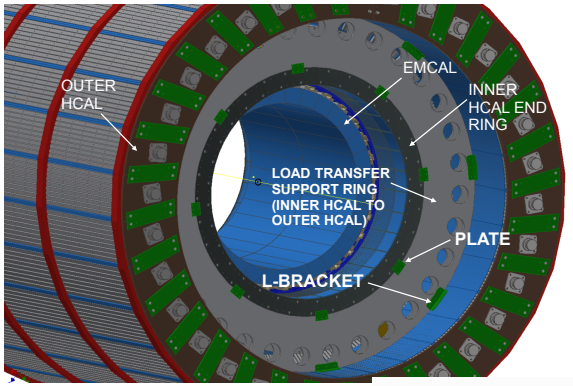
# Integration Scope

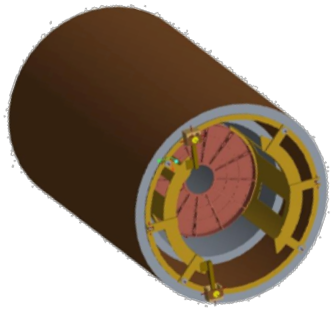
**Detector Major Components Exploded View**



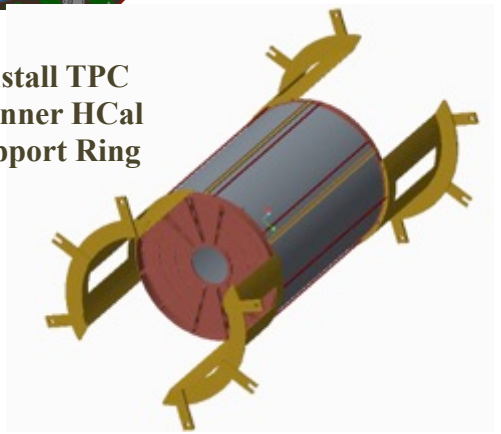

3D modeling of detector components

**Load Path from Inner detectors to Outer HCal**



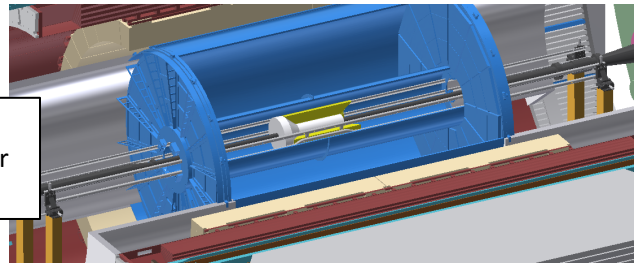
**Install TPC to Inner HCal Support Ring**



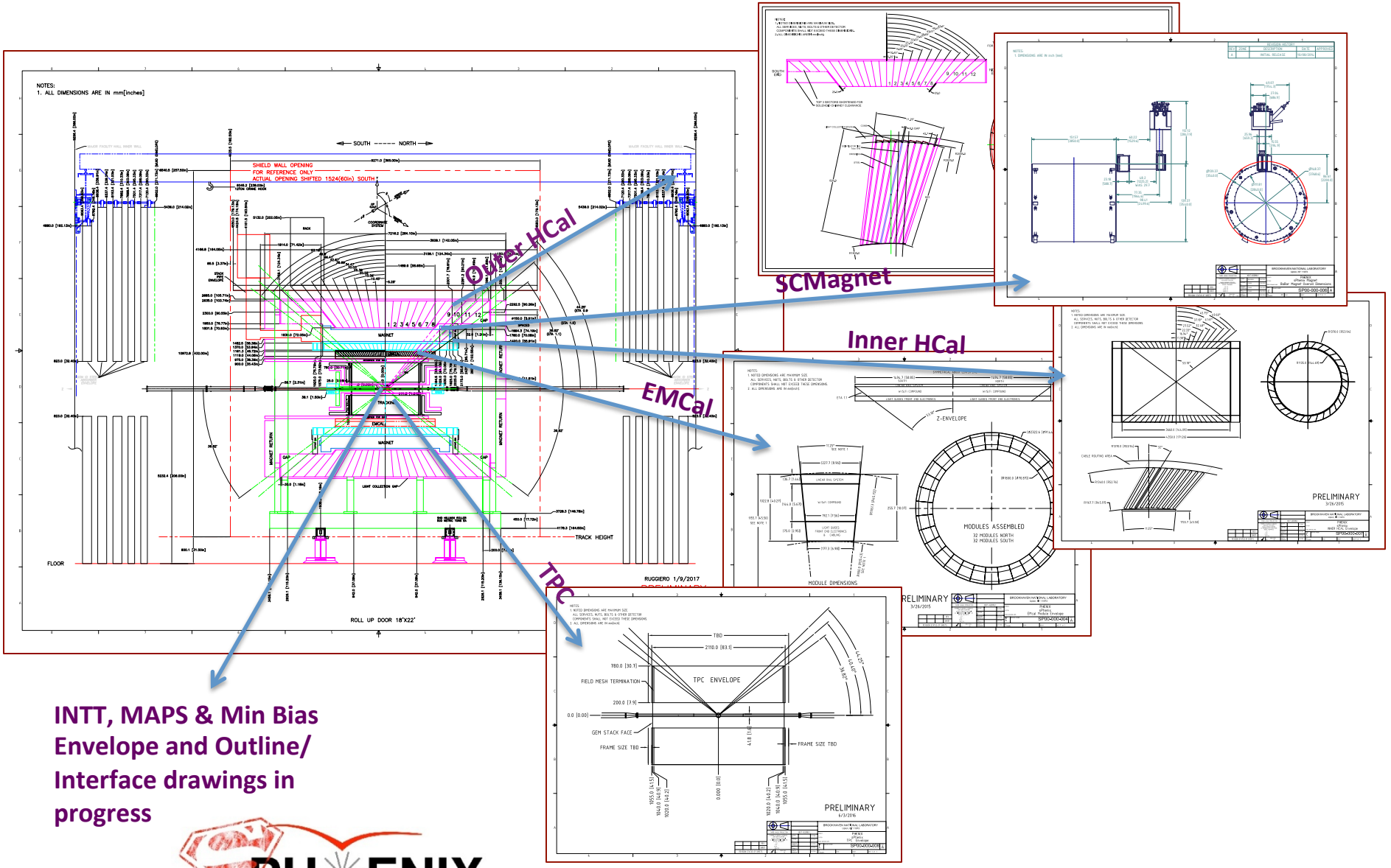
**Integration & Installation Design Drivers:**

- Subsystem design requirements
- Existing infrastructure (shield wall opening, Crane coverage and limits, rail layout)
- Minimum material in active areas
- Access for repair, maintenance, upgrade
- Safety
- Subsystem assembly requirements
- Subsystem support and alignment requirements

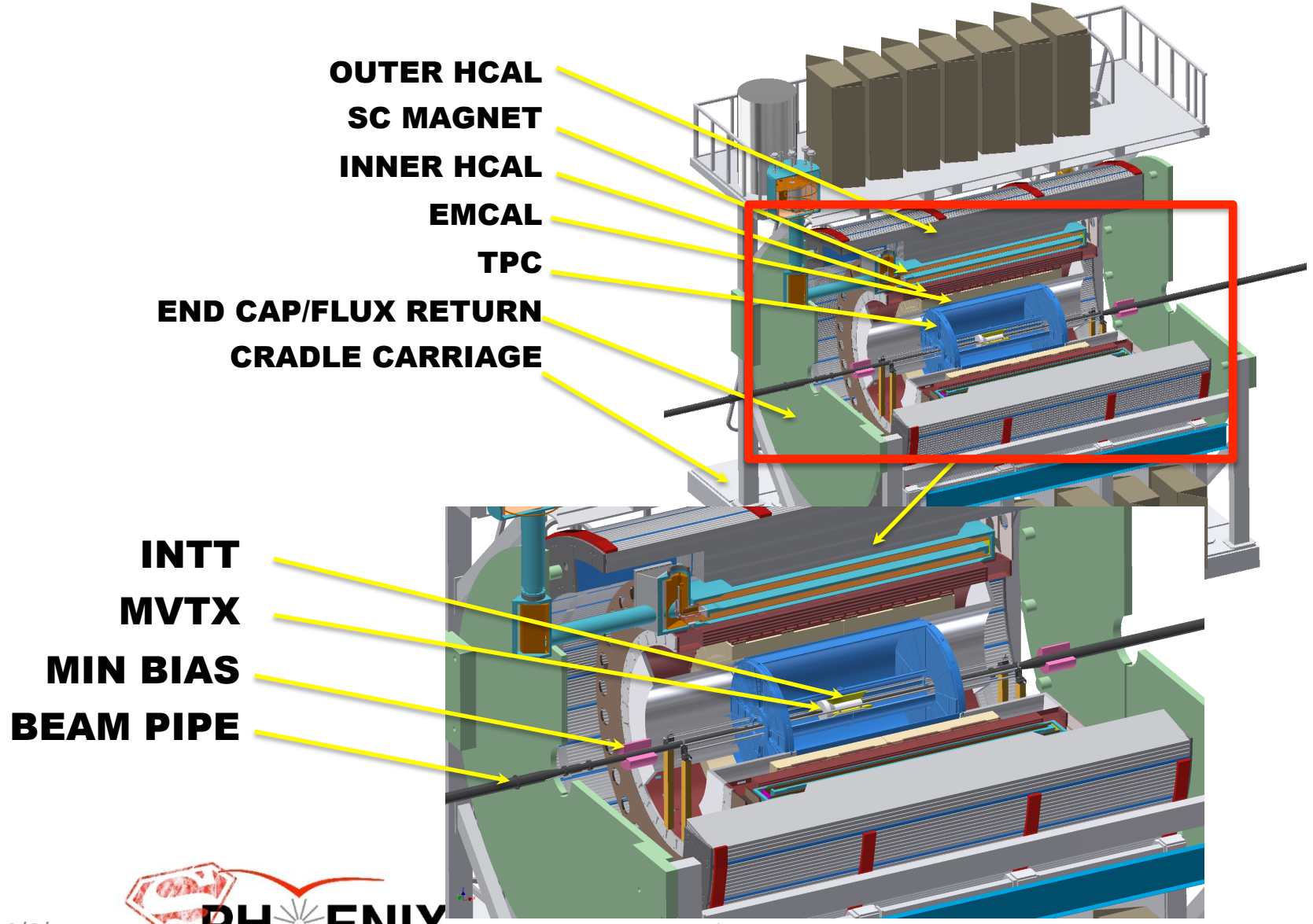
MVTX and INTT use common mounting but can be installed either or both, Min Bias not shown



# Status: SPHENIX ENVELOPE and Outline Interface DRAWINGS



# sPHENIX Assembly Cutaway

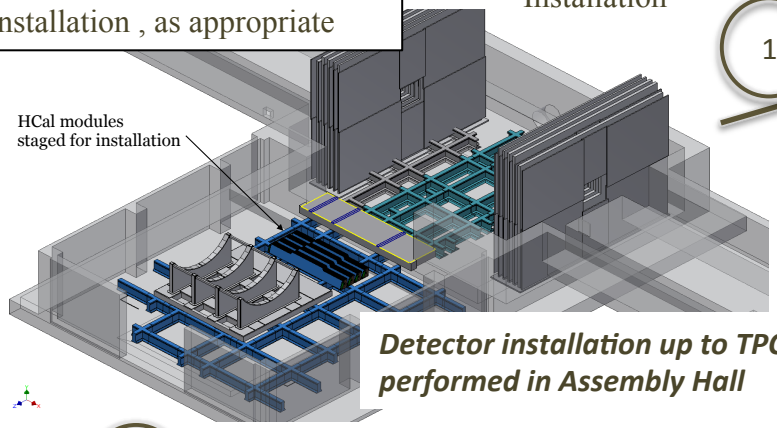


# Installation Scope

Infrastructure Installation performed prior to and in parallel with Detector Installation , as appropriate

Base and Cradle Installation

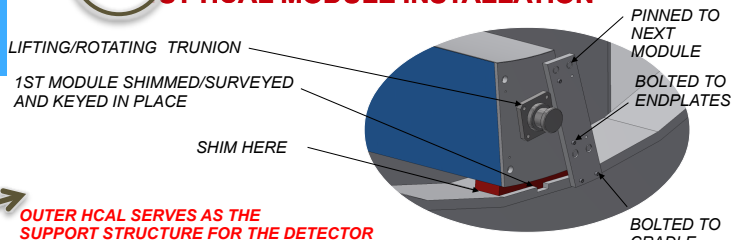
1



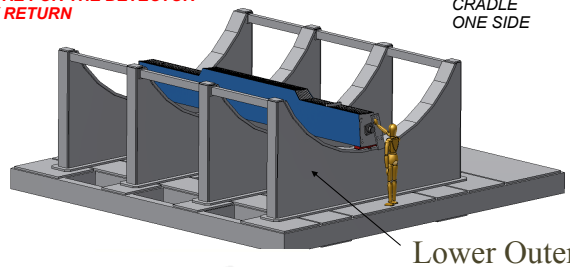

***Detector installation up to TPC performed in Assembly Hall***

2

**1ST HCAL MODULE INSTALLATION**




***OUTER HCAL SERVES AS THE SUPPORT STRUCTURE FOR THE DETECTOR AND MAGNET FLUX RETURN***



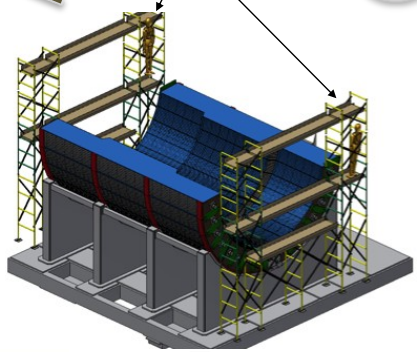
Magnet Installation

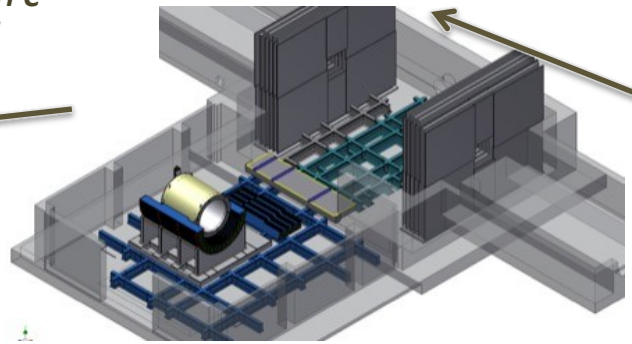
4

Lower Outer HCal Installation

*ACCESS SCAFFOLDING*

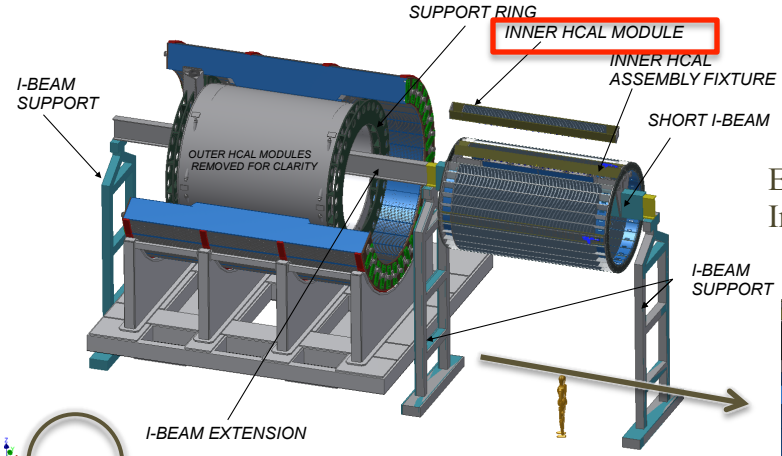
3





5

Upper Outer HCal Installation

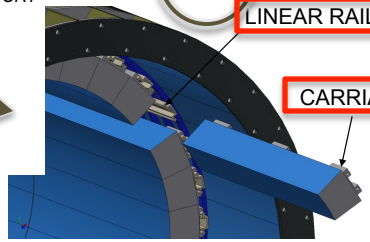



6

Inner HCal Installation

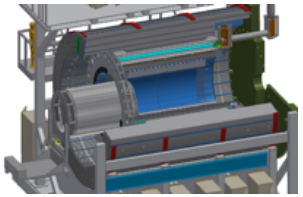
EMCal Installation

7

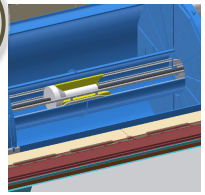



Tracker Installation

8



9

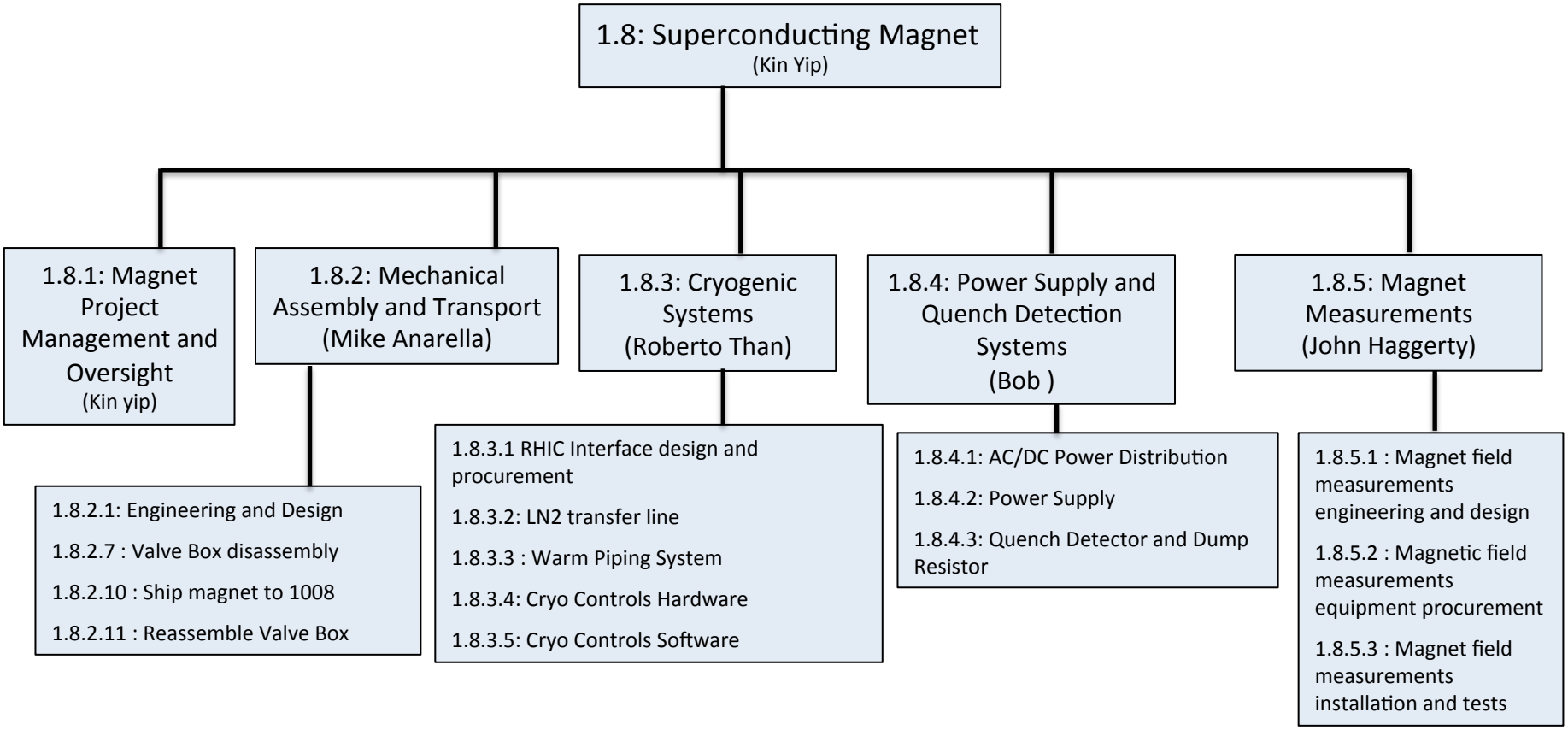


Move to IR, Install BP, INTT and MVTX

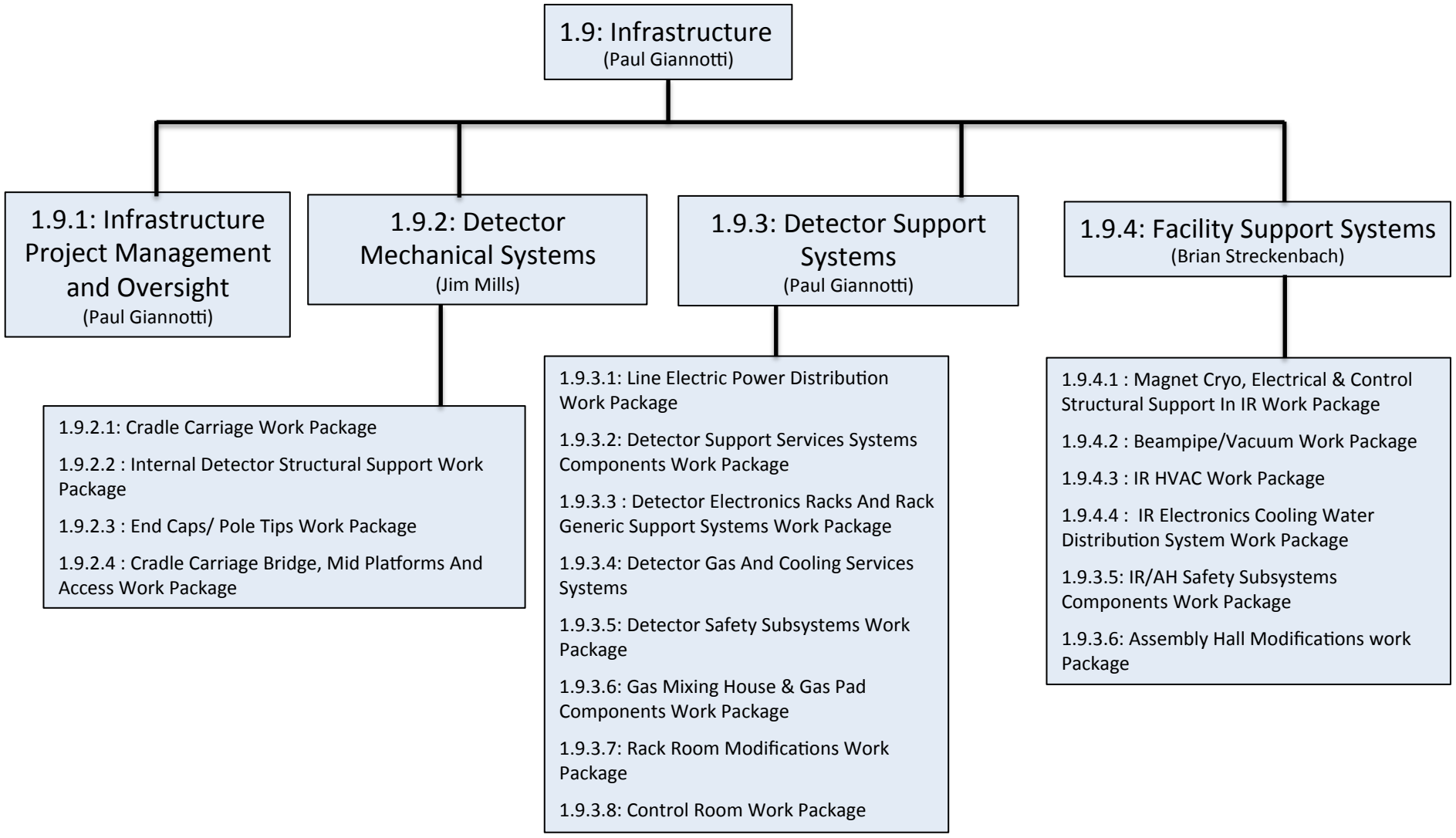
# Subsystem Responsibility (Schedule, Material, Labor) Matrix

| Item/Task Description | TPC WBS 1.2 | EMCal WBS 1.3 | In & Out HCal WBS 1.4 | Cal Electrcs WBS 1.5 | DAQ/Trig WBS 1.6 | Min Bias WBS 1.7 | SC-Magnet WBS 1.8 | Infra WBS 1.9 | Inst & Integ WBS 1.10 | INTT WBS 1.11 | MVTX WBS 1.12 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Detector active components | x | x | x | x | x | x | x | | | x | x |
| Detector enclosure | x | x | x | | | x | x | | | x | x |
| Detector (side) mounting interface | | | | | | | | | | | |
| Detector services connectors | x | x | x | x | x | x | x | | | x | x |
| Detector and detector services installation | | | | | | | | | x | | |
| Services from detector to patch panel, on carriage electronics racks, cooling/gas distribution panels | x | x | x | | | x | x | | | x | x |
| Subsystem commissioning (equipment) | x | x | x | x | x | x | x | | | x | x |
| Subsystem commissioning (labor) | | | | | | | | | x | | |
| Cryo lines and cryogenic delivery components, control and monitoring equipment | | | | | | | x | | | | |
| Electronics racks (on carriage and rack room), patch panels, distribution panels (design, fabrication assembly) and rack generic electronics, control and safety equipment | | | | | | | | x | | | |
| Subsystem specific rack electronics, control and safety equipment (on carriage and rack room) | x | x | x | x | x | x | x | | | x | x |
| Electronics racks (on carriage and rack room), patch panels, distribution panels and all internal components (installation) | | | | | | | | | x | | |
| Subsystem gas and cooling source (chillers, blowers, etc, including mixing house control electronics and mechanical mixing racks) | x | x | x | x | | x | | | | x | x |
| Water cooling (racks), line power, N2, dry air services design, procurement and assembly | | | | | | | | x | | | |
| Water cooling (racks), line power, N2, dry air services installation | | | | | | | | | x | | |
| Services extensions (piping, fiber trunk lines, services | | | | | | | | x | | | |
| Cradle carriage, subsystem mounting, positioning and alignment hardware | | | | | | | | | x | | |
| Subsystem assembly tooling and fixtures (sectors/modules) | x | x | x | x | x | x | x | x | | x | x |
| Subsystem and infrastructure installation, system assembly and all services installation | | | | | | | | | x | | |
| | | | | | | | | | | | |

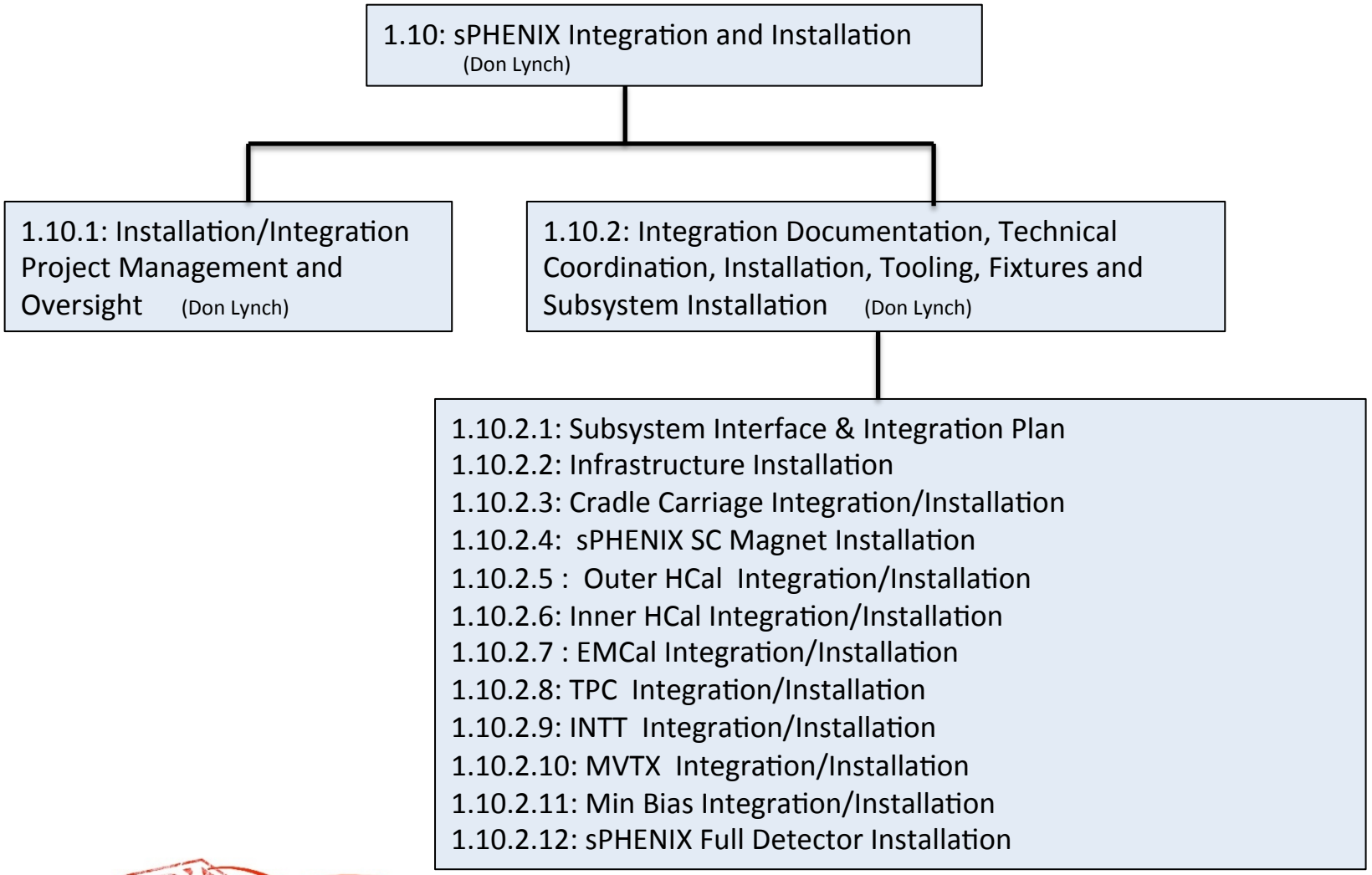
# WBS Structure: 1.8 Superconducting Magnet



# WBS Structure: 1.9 Infrastructure



# WBS Structure: 1.10 Integration and Installation



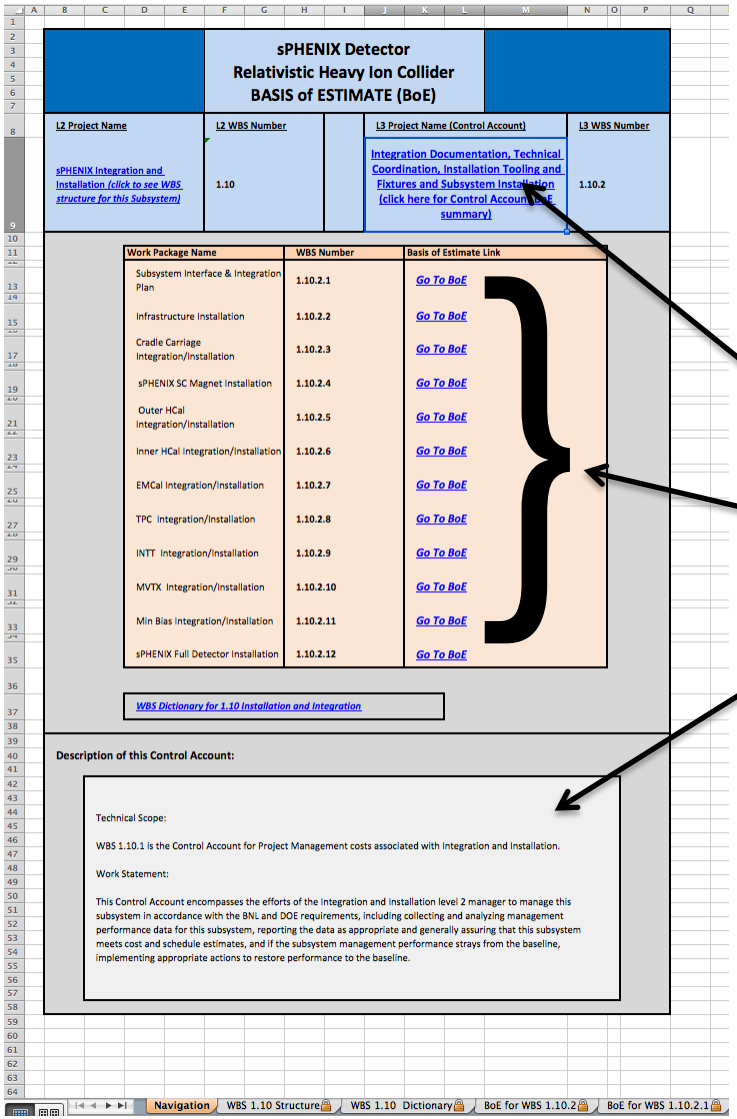
# Schedule and Major Milestones

| | |
|---|---|
| Removal of PHENIX components not used in sPHENIX complete | 3/31/2018 |
| Carriage & Support Structure Design Review | 4/27/18 |
| Installation Readiness Review (Tooling, Procedures, Safety)* | 1/7/2020 |
| Begin Assembling Carriage Base | 1/8/2020 |
| Begin Outer HCal Installation | 3/20/2020 |
| Begin Magnet Installation | 6/15/2020 |
| Begin Inner HCal Installation | 8/27/2020 |
| Begin EMCal Installation | 11/18/2020 |
| Begin TPC Installation | 1/8/2021 |
| Move Carriage to IR | 3/10/2021 |
| Begin INTT/MAPS Installation | 4/7/2021 |
| Complete Services Installation | 5/1/2021 |
| Commissioning (*non-beam*) Complete | 8/20/2021 |
| Operational Readiness Review ORR | 9/27/2021 |

** Final IRR; all subsystems initial IRR's complete)*

*(Note: Dates based on RSL as of 5/25/17. Include INTT and MVTX)*

# Documentation for Magnet, Infrastructure and Integration/Installation



**sPHENIX Detector**
**Relativistic Heavy Ion Collider**
**BASIS of ESTIMATE (BoE)**

| L2 Project Name | L2 WBS Number | | L3 Project Name (Control Account) | L3 WBS Number |
|---|---|---|---|---|
| sPHENIX Integration and Installation *(click to see WBS structure for this Subsystem)* | 1.10 | | Integration Documentation, Technical Coordination, Installation Tooling and Fixtures and Subsystem Installation (click here for Control Account BoE summary) | 1.10.2 |

| Work Package Name | WBS Number | Basis of Estimate Link |
|---|---|---|
| Subsystem Interface & Integration Plan | 1.10.2.1 | Go To BoE |
| Infrastructure Installation | 1.10.2.2 | Go To BoE |
| Cradle Carriage Integration/Installation | 1.10.2.3 | Go To BoE |
| sPHENIX SC Magnet Installation | 1.10.2.4 | Go To BoE |
| Outer HCal Integration/Installation | 1.10.2.5 | Go To BoE |
| Inner HCal Integration/Installation | 1.10.2.6 | Go To BoE |
| EMCal Integration/Installation | 1.10.2.7 | Go To BoE |
| TPC Integration/Installation | 1.10.2.8 | Go To BoE |
| INTT Integration/Installation | 1.10.2.9 | Go To BoE |
| MVTX Integration/Installation | 1.10.2.10 | Go To BoE |
| Min Bias Integration/Installation | 1.10.2.11 | Go To BoE |
| sPHENIX Full Detector Installation | 1.10.2.12 | Go To BoE |

*WBS Dictionary for 1.10 Installation and Integration*

**Description of this Control Account:**

Technical Scope:

WBS 1.10.1 is the Control Account for Project Management costs associated with Integration and Installation.

Work Statement:

This Control Account encompasses the efforts of the Integration and Installation level 2 manager to manage this subsystem in accordance with the BNL and DOE requirements, including collecting and analyzing management performance data for this subsystem, reporting the data as appropriate and generally assuring that this subsystem meets cost and schedule estimates, and if the subsystem management performance strays from the baseline, implementing appropriate actions to restore performance to the baseline.

Navigation | WBS 1.10 Structure | WBS 1.10 Dictionary | BoE for WBS 1.10.2 | BoE for WBS 1.10.2.1

Navigation Page

- 1st page in BoE EXCEL file
- Has link to CA summary BoE
- Has links to each work Package BoE
- Has the WBS Dictionary Entry for the CA

# Documentation for Magnet, Infrastructure and Integration/Installation

**sPHENIX Detector**
**Relativistic Heavy Ion Collider**
**BASIS of ESTIMATE (BoE)**

| | |
|---|---|
| Date of Est: | 3/27/17 |
| Prepared By: | D. Lynch |
| DocNo. (refer Rev. Log) | |

| WBS Title: | WBS number: | Control Account |
|---|---|---|
| Infrastructure Installation | 1.10.2.2 | TBD |

**WBS Dictionary Definition:**

**Technical Scope:**

This work package includes all scientific, engineering and technical staff efforts to install Infrastructure components and equipment in support of the sPHENIX detectors at 1008. T analyses required to determine the components and equipment needed, the design, procurement and acceptance of such equipment and reviews of these analyses are not in the scope of this work package and control account but rather are part of sPHENIX WBS 1.9: sPHENIX Infrastructure, and/or the specific detector subsystems (see WBS 1.9 BoE's for more detailed description of its scope).

**Work Statement:**

The specific Infrastructure installation tasks detailed in this work package are:

1. Line electric power distribution installation
2. Magnet cryogenic and electrical supply services structural support and cable/cryo fluids lines management installation.
3. Beampipe/vacuum equipment installation
4. IR HVAC equipment installation
5. On-detector and off-detector safety subsystems installation
6. Detector support services systems installations (signal, power and monitoring cable and fiber, services management and structural support, etc.)
7. Electronics racks installation (including patch panels)
8. Gas and cooling systemequipment and services installation. (including source, distribution monitoring and control systems)
9. Detector access and work platforms installation.
10. Non-IR infrastructure installation. (Including gas pad, gas mixing house, control room, rackroom, assembly areas and offices components and equipm

Return to Navigation Page

**Estimate Type (check all that apply):**

| | |
|---|---|
| | Work Complete |
| | Existing Purchase Order |
| | Catalog Listing or Industrial Construction Database |
| | Documented Vendor Quotation based on Drawings/Sketches/Specifications |
| | Budgetary Estimate by Vendor/Fabricator based on Sketches, Drawings, or other Written Correspondence |
| x | Engineering Estimate based on Similar Items or Procedures |
| x | Engineering Estimate based on Analysis |
| | Expert Opinion |

**Supporting Documents (including but not limited to):**

*(click here to see the details of the labor and material estimate for this Work Package)*

Navigation | WBS 1.10 Structure | WBS 1.10 Dictionary | BoE for WBS 1.10.2 | BoE for WBS 1.10.2

## BoE Summary Pages

- CA sheet and 1 for each WP
- Link to detail work sheets
- Cost summary
- Bottom up Contingency summary

**Assumptions Used in Developing Estimate**

1. Detector subsystems and Infrastructure subsystem will supply all equipment to be installed. This work package covers material procurements for hardware, special tools and fixtures required only for installation of the infrastructure items listed above in the "Dictionary Definition" section.
2. For equipment/components repurposed from items salvaged from the PHENIX removal and repurposing (R&R) efforts, only the labor required to repurpose the equipment is considered.
3. Infrastructure installation will commence as early as possible after (a) the infrastructure components/equipment has been provided by the infrastructure WBS, (b) PHENIX R&R has been completed and (c) CD2 authorization has been received for the sPHENIX MIE.
4. This work package describes the requirements, goals and concepts for integrating and installing the infrastructure components and equipment detector subsystems and ancillary subsytems. Actual design, approval and procurement of the components and equipment to be installed is the responsibility of the infrastructure subsytem (see WBS 1.9 for more details)."

**Details of the Base Estimate (explanation of the Work)**

This estimate covers the labor and material cost estimates for required for installation of components and equipment of sPHENIX infrastructure as indicated in the "Dictionary Definition" section above.

- Currently there is a good deal of infrastructure already in place and/or aallable from the sPHENIX R&R efforts, and this is taken into account in this estimate.
- All labor and material estimates are the result of engineering judgements based on similar requirements for infrastructure in similar projects (e.g. PHENIX, and recent PHENIX detectors.)
- Material for this work package is limited to hardware and installation specific tooling and fixtures.

Use the link inthe above "Suporting Documents" section to see details of the labor and material estimates for this work package.

**Cost Summary**

Cost summary for this work package is limited to hardware and installation specific tooling and fixtures for infrastructure installation tasks as indicated in the "Dictionary Definition" section above.

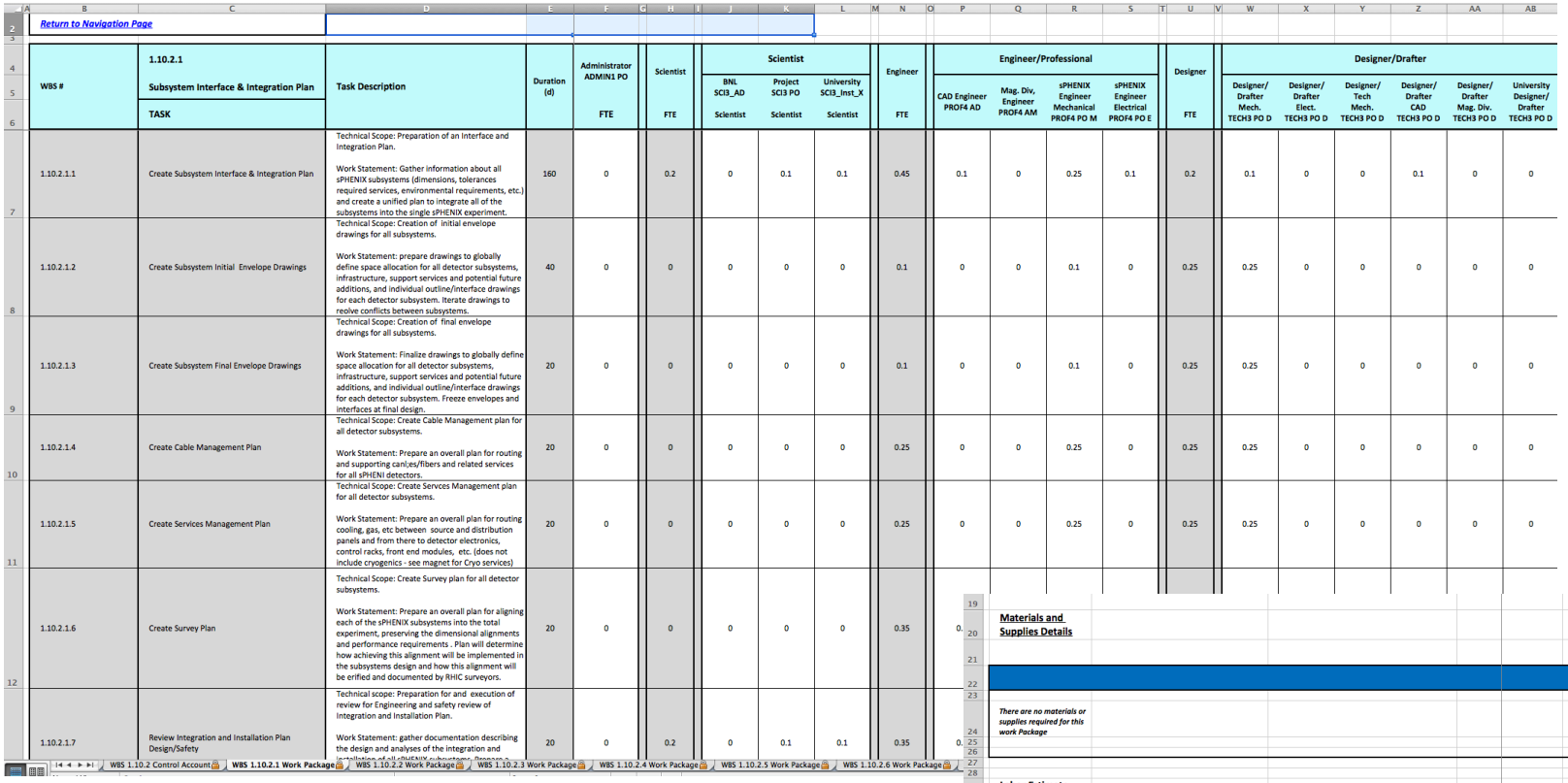
Total unburdened material cost for this work package = $5000

**Contingency**

Estimates for the labor and material described in this Work Package are currently based on Engineering estimates and analyses of infrastructure concepts based on evolving design of the individual subsystems. Contingency is assigned to each detail in the work package. The overall material contingency for this work package is determined by a weight averaged summation ("bottoms up") of the contingencies for the individual labor tasks and material items. Labor contingency for all labor is initially assumed at a constant 25%. As the work package's labor content becomes more well defined the individual labor contingencies for each task is reevaluated and the composite contingency calculated as weight averaged in accordance with the total estimated (unburdened) labor cost for the task.

| | | |
|---|---|---|
| Bottoms Up Composite Labor contingency for WBS #1.10.2.2: Infrastructure Installation | Labor Contingency: | 25% |
| | Material | 25% |

# Documentation for Magnet, Infrastructure and Integration/Installation



Return to Navigation Page

| WBS # | 1.10.2.1 Subsystem Interface & Integration Plan TASK | Task Description | Duration (d) | Administrator ADMIN1 PO FTE | Scientist FTE | Scientist: BNL SCI3_AD Scientist | Scientist: Project SCI3 PO Scientist | Scientist: University SCI3_Inst_X Scientist | Engineer FTE | Engineer/Professional: CAD Engineer PROF4 AD | Engineer/Professional: Mag. Div. Engineer PROF4 AM | Engineer/Professional: sPHENIX Engineer Mechanical PROF4 PO M | Engineer/Professional: sPHENIX Engineer Electrical PROF4 PO E | Designer FTE | Designer/Drafter: Designer/ Drafter Mech. TECH3 PO D | Designer/Drafter: Designer/ Drafter Elect. TECH3 PO D | Designer/Drafter: Designer/ Tech Mech. TECH3 PO D | Designer/Drafter: Designer/ Drafter CAD TECH3 PO D | Designer/Drafter: Designer/ Drafter Mag. Div. TECH3 PO D | Designer/Drafter: University Designer/ Drafter TECH3 PO D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.10.2.1.1 | Create Subsystem Interface & Integration Plan | Technical Scope: Preparation of an Interface and Integration Plan. Work Statement: Gather information about all sPHENIX subsystems (dimensions, tolerances required services, environmental requirements, etc.) and create a unified plan to integrate all of the subsystems into the single sPHENIX experiment. | 160 | 0 | 0.2 | 0 | 0.1 | 0.1 | 0.45 | 0.1 | 0 | 0.25 | 0.1 | 0.2 | 0.1 | 0 | 0 | 0.1 | 0 | 0 |
| 1.10.2.1.2 | Create Subsystem Initial Envelope Drawings | Technical Scope: Creation of initial envelope drawings for all subsystems. Work Statement: prepare drawings to globally define space allocation for all detector subsystems, infrastructure, support services and potential future additions, and individual outline/interface drawings for each detector subsystem. Iterate drawings to reolve conflicts between subsystems. | 40 | 0 | 0 | 0 | 0 | 0 | 0.1 | 0 | 0 | 0.1 | 0 | 0.25 | 0.25 | 0 | 0 | 0 | 0 | 0 |
| 1.10.2.1.3 | Create Subsystem Final Envelope Drawings | Technical Scope: Creation of final envelope drawings for all subsystems. Work Statement: Finalize drawings to globally define space allocation for all detector subsystems, infrastructure, support services and potential future additions, and individual outline/interface drawings for each detector subsystem. Freeze envelopes and interfaces at final design. | 20 | 0 | 0 | 0 | 0 | 0 | 0.1 | 0 | 0 | 0.1 | 0 | 0.25 | 0.25 | 0 | 0 | 0 | 0 | 0 |
| 1.10.2.1.4 | Create Cable Management Plan | Technical Scope: Create Cable Management plan for all detector subsystems. Work Statement: Prepare an overall plan for routing and supporting can|es/fibers and related services for all sPHENI detectors. | 20 | 0 | 0 | 0 | 0 | 0 | 0.25 | 0 | 0 | 0.25 | 0 | 0.25 | 0.25 | 0 | 0 | 0 | 0 | 0 |
| 1.10.2.1.5 | Create Services Management Plan | Technical Scope: Create Servces Management plan for all detector subsystems. Work Statement: Prepare an overall plan for routing cooling, gas, etc between source and distribution panels and from there to detector electronics, control racks, front end modules, etc. (does not include cryogenics - see magnet for Cryo services) | 20 | 0 | 0 | 0 | 0 | 0 | 0.25 | 0 | 0 | 0.25 | 0 | 0.25 | 0.25 | 0 | 0 | 0 | 0 | 0 |
| 1.10.2.1.6 | Create Survey Plan | Technical Scope: Create Survey plan for all detector subsystems. Work Statement: Prepare an overall plan for aligning each of the sPHENIX subsystems into the total experiment, preserving the dimensional alignments and performance requirements . Plan will determine how achieving this alignment will be implemented in the subsystems design and how this alignment will be erified and documented by RHIC surveyors. | 20 | 0 | 0 | 0 | 0 | 0 | 0.35 | 0. | | | | | | | | | | |
| 1.10.2.1.7 | Review Integration and Installation Plan Design/Safety | Technical scope: Preparation for and execution of review for Engineering and safety review of Integration and Installation Plan. Work Statement: gather documentation describing the design and analyses of the integration and | 20 | 0 | 0.2 | 0 | 0.1 | 0.1 | 0.35 | 0. | | | | | | | | | | |

WBS 1.10.2 Control Account | WBS 1.10.2.1 Work Package | WBS 1.10.2.2 Work Package | WBS 1.10.2.3 Work Package | WBS 1.10.2.4 Work Package | WBS 1.10.2.5 Work Package | WBS 1.10.2.6 Work Package

**Materials and Supplies Details**

*There are no materials or supplies required for this work Package*

**Labor Estimate Details**

| WBS | Description | Step | Duration | Resource | Qty (Repeats) | Total |
|---|---|---|---|---|---|---|
| 1.10.2.1.1 | Create Subsystem Interface & Integration Plan | | 20 | | | |
| | | | | SCI3_PO | | |
| 1.10.2.1.2 | Create Subsystem Initial Envelope Drawings | | | | | |
| 1.10.2.1.3 | Create Subsystem Final Envelope Drawings | | | | | |
| 1.10.2.1.4 | Create Cable Management Plan | | | | | |
| 1.10.2.1.5 | Create Services Management Plan | | | | | |
| 1.10.2.1.6 | Create Survey Plan | | | | | |
| 1.10.2.1.7 | Review Integration and Installation Plan Design/Safety | | | | | |
| 1.10.2.1.8 | Review Cable Management Plan | | | | | |
| 1.10.2.1.9 | Review Survey Plan | | | | | |
| 1.10.2.1.10 | Address Action Items from Subsystem Interface & Integration Plans (Interface, Integration, Cable Design/Safety Reviews Complete, Ready to Begin Installation | | | | | |
| 1.10.2.1.11 | | | | | | |

## Calculation Detail Pages

- CA sheet and 1 for each WP
- Detailed analyses of labor and material costs
- Source for all summary pages
- Links to quotations, web sources, etc.

# Risk Registry

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 29 | K. Yip | 1.8 SuperConducting Magnet | Magnet does not work; cannot achieve specified field | Failure of magnet to reach field. Possible causes, Internal electrical failure, vacuum leak failure, cryo system failure, Power supply failure | Detector System can't resolve data without adequate magnetic field. Rework of magnet to correct deficiency is necessary | All | Low 10% | High: Cost ~$100-500K schedule 6-12 mos | Moderate | Full field test at bldg 912 prior to transport to bldg 1008 to proe out magnet performance, cryo, power supply and quench detection systems. Electrical check (warm) at 1008 to check for faults induced in shipping. Final full field/mapping test in 1008 IR. |
| 30 | P. Giannotti | 1.9 Infrastructure | Engineering Resources not available | Engineering not available for timely design efforts | Cascading delays to production, assembly and installation | Design | Moderate: 30% | Moderate: Cost: $0, Schedule: 0-6 months | Moderate | Schedule relies on significant engineering resources not yet fully committed. Get early commitments from contributing groups for timely participation |
| 31 | P. Giannotti | 1.9 Infrastructure | Cradle Fabrication delayed | Fabrication delayed | Cradle not available on time to commence assembly and installation | Installation | low: 10% | Moderate: Cost: $0, Schedule: 0-6 months | Low | Reliable experienced fabricator(s), adequate schedule contingency |
| 32 | D. Lynch | 1.10 Integration and Installation | Subsystem not ready for installation | Subsystem not delivered in time for scheduled installation | Delays in construction/installation of sPHENIX | Installation | Moderate: 30% | Moderate: Cost: $0, Schedule: 0-6 months | Moderate | Build in adequate schedule contingency |
| 33 | D. Lynch | 1.10 Integration and Installation | Labor not available for installation | Labor not available for timely installation | Delays in construction/installation of sPHENIX | Installation | low: 10% | Moderate: Cost: 0-$20K, Schedule: 0-6 months | Low | Secure more labor support/ temporary hires |
| 34 | D. Lynch | 1.10 Integration and Installation | Pole Tips delayed | Fabrication delayed | Pole tips not available when scheduled for installation:delays move to IR for following installation. | Installation | low: 10% | Moderate: Cost: $0, Schedule: 0-6 months | Low | Reliable experienced fabricator(s), adequate schedule contingency (pole tips installation near end of installation schedule) |

There is a Risk Registry section for the Magnet, Infrastructure and Integration/Installation non-MIE subsystems, managed and monitored the same as for the MIE items. In addition to the obvious Risk of a non-performing magnet (mitigated by testing the magnet prior to the commencement of installation and carefully monitoring it after each handling operation) Other Risk issues generally have to do with availability of labor and material in a timely fashion. These are mitigated by having a tight management structure for MIE and non-MIE subsystems.